



Technical Memorandum

To: John R. Yagecic, P.E.

From: Timothy D. Bradley, P.E.

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cc: Namsoo Suk, Tom Amidon, Tushar Roy, Erin Dovel

Re: Nitrogen Reduction Cost Estimation Study
Generic Plant Capital Cost Estimates

1.0 INTRODUCTION

This Technical Memorandum presents capital cost estimates to upgrade the three (3) generic plants to achieve the three (3) agreed upon effluent levels for ammonia nitrogen ($\text{NH}_3\text{-N}$) reduction and the one (1) agreed upon effluent level for total nitrogen (TN) reduction utilizing the agreed upon technology recommendations. A summary of the previously agreed upon effluent levels and technology recommendation is presented in Table 1.

Table 1: Final Technology and Effluent Level Recommendations

Effluent Level	Generic Conventional Activated Sludge Plant	Generic Pure Oxygen Activated Sludge Plant	Generic Fixed Film (RBC and TF) Plant
$\text{NH}_3\text{-N}$ – 10 mg/L	Replace process air system, construct additional final clarifiers and modify RAS system	Add downstream BAF sized for approximately 50% of plant flow	Add downstream BAF sized for approximately 45% of plant flow
$\text{NH}_3\text{-N}$ – 5 mg/L	Conversion to IFAS with medium level of media addition to aeration tanks	Add downstream BAF sized for approximately 75% of plant flow	Add downstream BAF sized for approximately 70% of plant flow
$\text{NH}_3\text{-N}$ – 1.5 mg/L	Conversion to IFAS with high level of media addition to aeration tanks	Add downstream BAF sized for 100% of plant flow	Add downstream BAF sized for 100% of plant flow
TN – 4 mg/L	Conversion to IFAS with high level of media addition plus downstream DF	Add downstream BAF sized for 100% of plant flow plus DF	Add downstream BAF sized for 100% of plant flow plus DF

The resulting generic plant capital cost estimates are used in conjunction with the annual average flows for the three (3) generic plants to establish the budgetary capital costs on a \$/gpd basis to achieve each effluent level presented in the above table.

The generic plant capital cost estimates on a \$/gpd basis will be used as the starting point to develop plant-specific capital cost estimates for each of the twelve (12) plants in Task 8.

2.0 BASIS FOR GENERIC PLANT CAPITAL COST ESTIMATES

The generic plant capital cost estimates presented herein are based on the following:

- ∞ Major equipment costs utilizing budgetary quotes from non-proprietary equipment manufacturers and typical installation cost as a percentage of equipment cost per Kleinfelder experience.
- ∞ Estimated quantities and unit costs for:
 - Cast-in-place concrete
 - Earth excavation and backfill
 - Buildings
- ∞ Typical percentages for: site work, site piping, electrical, and instrumentation and control (I&C) based on nature of the upgrades and Kleinfelder's experience.
- ∞ Contractor Overhead and Profit of 24%, which includes mobilization, demobilization and Contractor general conditions.
- ∞ Contingency of 30% to reflect a pre-design planning level of accuracy.
- ∞ Engineering, Legal and Administrative costs of 20%.

Based on the cost estimating methodology describe above, the generic plant cost estimates are consistent with an American Association of Cost Estimating (AACE) Level 4 estimate, which is the appropriate level for the study phase of a project. Therefore, the generic plant capital cost estimates are budgetary estimates.

The generic plant capital cost estimates are in 2019 dollars corresponding to an Engineering News Record (ENR) Twenty City Cost Index of 11311. This index can be used in the future to update the budgetary 2019 costs due to the inflation of construction costs between 2019 and the future date.

The generic plant capital cost estimates do not include costs for the following, which will be included in the plant-specific cost estimates as appropriate:

- ∞ Land acquisition
- ∞ Rock excavation
- ∞ Pile-supported foundations
- ∞ Sheet piling or dewatering
- ∞ Additional sludge processing equipment

The generic plant capital cost estimates follow, beginning with the Generic Pure Oxygen Activated Sludge Plant Capital Cost Estimates.

3.0 GENERIC PURE OXYGEN ACTIVATED SLUDGE PLANT CAPITAL COSTS

As described in the Generic Plant Descriptions Technical Memorandum dated July 19, 2019, the characteristics of the Generic Pure Oxygen Activated Sludge Plant (also referred to as the Generic Pure Oxygen Plant) are listed in Table 2.

Table 2: Generic Pure Oxygen Activated Sludge Plant Characteristics

Parameter	Value
Influent Annual Average Flow	83 mgd
Influent Maximum Monthly (30-day average) Flow	97 mgd
Influent Maximum Daily (24-hour average) Flow	170 mgd
Influent Average CBOD Concentration	220 mg/L
Influent Average TSS Concentration	250 mg/L
Influent Average NH ₃ -N Concentration	25 mg/L
Recycle Average Flow from Thickening and Dewatering	8 mgd
Recycle Flow Average CBOD Concentration	800 mg/L
Recycle Flow Average TSS Concentration	500 mg/L
Recycle Flow Average NH ₃ -N Concentration	120 mg/L
Effluent Average CBOD Concentration	5 mg/L
Effluent Average TSS Concentration	6 mg/L
Effluent Summer Max. Monthly Average NH ₃ -N Concentration	26 mg/L
Effluent Average NH ₃ -N Concentration	19 mg/L
Effluent Min. Monthly Summer Temperature (C)	18°

As further described in the Effluent Levels Technical Memorandum, the plant upgrade improvements will be sized to achieve the effluent levels each month of the summer season defined as May 1 through October 31, rather than each month of the year. Therefore, the improvements for each effluent level will be sized for the maximum monthly average (i.e., maximum 30-day average flow) rather than the annual average flow and will be sized for the minimum temperature that occurs in the summer season rather than the minimum temperature that occurs in the winter.

The resulting sizing criteria for the biological aerated filter (BAF) process are summarized in Table 3.

Table 3: Generic Pure Oxygen Plant BAF Design/Sizing Criteria

Effluent Level	BAF Influent NH ₃	BAF Influent BOD	Max. Monthly Average Flow	Minimum Monthly Avg. Temperature	Required BAF Effluent NH ₃
10 mg/L NH ₃	19 mg/L	5 mg/L	49 mgd	18 deg C	1.5 mg/L
5 mg/L NH ₃	19 mg/L	5 mg/L	73 mgd	18 deg C	1.5 mg/L
1.5 mg/L NH ₃	19 mg/L	5 mg/L	97 mgd	18 deg C	1.5 mg/L

Similarly, the resulting sizing criteria for the Generic Pure Oxygen Plant denitrification filter are summarized in Table 4.

Table 4: Generic Pure Oxygen Plant Denitrification Filter Design/Sizing Criteria

Effluent Level	DF Influent NH ₃	DF Influent NO ₃	DF Influent BOD	Max. Monthly Average Flow ⁽¹⁾	Minimum Monthly Avg. Temperature	Required DF Effluent TN
4 mg/L TN	1.5 mg/L	24.5 mg/L	2 mg/L	97 mgd	18 deg C	4 mg/L

To support the addition of BAFs and a denitrification filter, the additional improvements listed in Table 5 have been included for the Generic Pure Oxygen Plant and will be modified as appropriate for the plant specific cost estimates.

Table 5: Generic Pure Oxygen Plant – Related Additional Improvements

Effluent Level	Additional Improvements
NH ₃ -N – 10 mg/L	Intermediate Pump Station – 49 mgd firm capacity and TDH based on BAF headloss Alkalinity Storage and Feed System and new Chemical Building BAF Gallery Building and Backwash pumping station
NH ₃ -N – 5 mg/L	Intermediate Pump Station – 73 mgd firm capacity and TDH based on BAF headloss Alkalinity Storage and Feed System and new Chemical Building BAF Gallery Building and Backwash pumping station
NH ₃ -N – 1.5 mg/L	Intermediate Pump Station – 97 mgd firm capacity and TDH based on BAF headloss Alkalinity Storage and Feed System and new Chemical Building BAF Gallery Building and Backwash Pumping Station
TN – 4 mg/L	Intermediate Pump Station - 97 mgd firm capacity and TDH based on BAF +DF HL Alkalinity Storage and Feed System and new Chemical Building Methanol Storage and Feed System and New Chemical Building BAF Gallery Building, DF Gallery Building and Backwash pumping stations

To aid in the understanding of the improvements to achieve the various effluent levels, Figure 1 in Appendix A is a process flow diagram of the existing Generic Pure Oxygen Plant; Figure 2

depicts the improvements for the 3 levels of NH₃ reduction; and Figure 3 depicts the improvements for the effluent TN level of 4 mg/L.

The Generic Pure Oxygen Activated Sludge Plant capital cost estimates for the four (4) effluent limit scenarios follow.

Table 6: Generic Pure Oxygen Plant Capital Cost Estimate for NH₃-N of 10 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
49 MGD BAF System	1	LS	\$ 11,700,000	\$ 11,700,000	Quote from Kruger
New BAF feed pumps	3	LS	\$ 230,000	\$ 690,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 365,000	\$ 365,000	Quote from PEP
Piping, valves and accessories @20%				\$ 2,551,000	
			<i>Subtotal</i>	\$ 15,306,000	
Installation		25%		\$ 3,826,500	
			<i>Major Equipment & Systems Subtotal</i>	<i>19,132,500</i>	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	240	CY	\$ 950	\$ 228,000	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	225	CY	\$ 600	\$ 135,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	2730	CY	\$ 950	\$ 2,593,500	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	2040	CY	\$ 600	\$ 1,224,000	Unit quote from similar project
Excavation/Backfill - BAF feed PS	2365	CY	\$ 58	\$ 137,170	RSMMeans 2019 Estimate
Excavation/Backfill - BAF System	6290	CY	\$ 58	\$ 364,820	RSMMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
			<i>Unit Price & Other Item Subtotal</i>	<i>4,882,490</i>	
Buildings					
Chemical Building - Alkalinity	3300	SF	\$ 350	\$ 1,155,000	Complete with lighting and HVAC
BAF - Gallery Building	5320	SF	\$ 350	\$ 1,862,000	Complete with lighting and HVAC
BAF feed pump building	2700	SF	\$ 350	\$ 945,000	Complete with lighting and HVAC
			<i>Buildings Subtotal</i>	<i>\$ 3,962,000</i>	
Bulk Work Percentage					
Civil Site		10%		\$ 2,798,000	
Electrical		20%		\$ 5,595,000	
Instrumentation & Controls		10%		\$ 2,798,000	
Site Piping		15%		\$ 4,197,000	
			<i>Bulk Work Subtotal</i>	<i>15,388,000</i>	
			Subtotal Direct Costs	\$ 43,365,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 10,408,000	Also includes General Conditions
Contingency		30%		\$ 13,010,000	
			TOTAL BUDGETARY CONSTRUCTION COST	\$ 66,783,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 13,356,600	
			TOTAL BUDGETARY CAPITAL COST	\$80,140,000	

Table 7: Generic Pure Oxygen Plant Capital Cost Estimate for NH₃-N of 5 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
73 MGD BAF System	1	LS	\$ 15,400,000	\$ 15,400,000	Quote from Kruger
New BAF feed pumps	4	LS	\$ 230,000	\$ 920,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 530,000	\$ 530,000	Quote from PEP
Piping, valves and accessories @20%				\$ 3,370,000	
			<i>Subtotal</i>	\$ 20,220,000	
Installation		25%		\$ 5,055,000	
			<i>Major Equipment & Systems Subtotal</i>	25,275,000	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	325	CY	\$ 950	\$ 308,750	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	300	CY	\$ 600	\$ 180,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	3630	CY	\$ 950	\$ 3,448,500	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	2860	CY	\$ 600	\$ 1,716,000	Unit quote from similar project
Excavation/Backfill - BAF feed PS	3150	CY	\$ 58	\$ 182,700	RSMeans 2019 Estimate
Excavation/Backfill - BAF System	9020	CY	\$ 58	\$ 523,160	RSMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
			<i>Unit Price & Other Item Subtotal</i>	6,559,110	
Buildings					
Chemical Building - Alkalinity	5000	SF	\$ 350	\$ 1,750,000	Complete with lighting and HVAC
BAF - Gallery Building	5840	SF	\$ 350	\$ 2,044,000	Complete with lighting and HVAC
BAF feed pump building	3375	SF	\$ 350	\$ 1,181,250	Complete with lighting and HVAC
			<i>Buildings Subtotal</i>	4,975,250	
Bulk Work Percentage					
Civil Site		10%		\$ 3,681,000	
Electrical		20%		\$ 7,362,000	
Instrumentation & Controls		10%		\$ 3,681,000	
Site Piping		15%		\$ 5,521,000	
			<i>Bulk Work Subtotal</i>	20,245,000	
Subtotal Direct Costs				\$ 57,054,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 13,693,000	Also includes General Conditions
Contingency		30%		\$ 17,116,000	
TOTAL BUDGETARY CONSTRUCTION COST				\$ 87,863,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 17,572,600	
TOTAL BUDGETARY CAPITAL COST				\$ 105,436,000	

Table 8: Generic Pure Oxygen Plant Capital Cost Estimate for NH₃-N of 1.5 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
97 MGD BAF System	1	LS	\$ 19,800,000	\$ 19,800,000	Quote from Kruger
New BAF feed pumps	5	LS	\$ 230,000	\$ 1,150,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 695,000	\$ 695,000	Quote from PEP
Piping, valves and accessories @20%				\$ 4,329,000	
			<i>Subtotal</i>	\$ 25,974,000	
Installation		25%		\$ 6,493,500	
			<i>Major Equipment & Systems Subtotal</i>	32,467,500	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	410	CY	\$ 950	\$ 389,500	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	380	CY	\$ 600	\$ 228,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	4885	CY	\$ 950	\$ 4,640,750	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	3920	CY	\$ 600	\$ 2,352,000	Unit quote from similar project
Excavation/Backfill - BAF feed PS	3950	CY	\$ 58	\$ 229,100	RSMeans 2019 Estimate
Excavation/Backfill - BAF System	12570	CY	\$ 58	\$ 729,060	RSMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
			<i>Unit Price & Other Item Subtotal</i>	8,768,410	
Buildings					
Chemical Building - Alkalinity	5500	SF	\$ 350	\$ 1,925,000	Complete with lighting and HVAC
BAF - Gallery Building	6080	SF	\$ 350	\$ 2,128,000	Complete with lighting and HVAC
BAF feed pump building	4050	SF	\$ 350	\$ 1,417,500	Complete with lighting and HVAC
			<i>Buildings Subtotal</i>	5,470,500	
Bulk Work Percentage					
Civil Site		10%		\$ 4,671,000	
Electrical		20%		\$ 9,341,000	
Instrumentation & Controls		10%		\$ 4,671,000	
Site Piping		15%		\$ 7,006,000	
			<i>Bulk Work Subtotal</i>	25,689,000	
Subtotal Direct Costs				\$ 72,395,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 17,375,000	Also includes General Conditions
Contingency		30%		\$ 21,719,000	
TOTAL BUDGETARY CONSTRUCTION COST				\$ 111,489,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 22,297,800	
TOTAL BUDGETARY CAPITAL COST				\$ 133,787,000	

Table 9: Generic Pure Oxygen Plant Capital Cost Estimate for TN of 4 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
97 MGD BAF System	1	LS	\$ 19,800,000	\$ 19,800,000	Quote from Kruger
New BAF feed pumps	5	LS	\$ 230,000	\$ 1,150,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 695,000	\$ 695,000	Quote from PEP
New Denite filter feed pumps	5	LS	\$ 230,000	\$ 1,150,000	Quote from ABS
Denite filters w/BW pumps, blowers and methanol storage	1	LS	\$ 29,000,000	\$ 29,000,000	Quote from DeNora
Piping, valves and accessories @20%				\$ 10,359,000	
			<i>Subtotal</i>	\$ 62,154,000	
Installation		25%		\$ 15,538,500	
			Major Equipment & Systems Subtotal	77,692,500	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	820	CY	\$ 950	\$ 779,000	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	760	CY	\$ 600	\$ 456,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	4885	CY	\$ 950	\$ 4,640,750	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	3920	CY	\$ 600	\$ 2,352,000	Unit quote from similar project
Cast in Place Conc. - Denite Filter	17530	CY	\$ 950	\$ 16,653,500	Unit quote from similar project
Cast in Place Conc. Foundation -Denite Filter	7230	CY	\$ 600	\$ 4,338,000	Unit quote from similar project
Methanol Storage pad w/ containment	960	CY	\$ 600	\$ 576,000	Unit quote from similar project
Excavation/Backfill - BAF and Denite feed PS	7900	CY	\$ 58	\$ 458,200	RSMeans 2019 Estimate
Excavation/Backfill - BAF System	12570	CY	\$ 58	\$ 729,060	RSMeans 2019 Estimate
Excavation/Backfill - Denite Filter	8375	CY	\$ 58	\$ 485,750	RSMeans 2019 Estimate
Excavation - Methanol storage system	3850	CY	\$ 58	\$ 223,300	RSMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
			Unit Price & Other Item Subtotal	31,891,560	
Buildings					
Chemical Building - Alkalinity	5500	SF	\$ 350	\$ 1,925,000	Complete with lighting and HVAC
BAF - Gallery Building	6080	SF	\$ 350	\$ 2,128,000	Complete with lighting and HVAC
Denitrification Filter - Gallery Building	2500	SF	\$ 350	\$ 875,000	Complete with lighting and HVAC
BAF and Denite feed pump building	8100	SF	\$ 350	\$ 2,835,000	Complete with lighting and HVAC
			Buildings Subtotal	7,763,000	
Bulk Work Percentage					
Civil Site		10%		\$ 11,735,000	
Electrical		20%		\$ 23,469,000	
Instrumentation & Controls		10%		\$ 11,735,000	
Site Piping		15%		\$ 17,602,000	
			Bulk Work Subtotal	64,541,000	
			Subtotal Direct Costs	\$ 181,888,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 43,653,000	Also includes General Conditions
Contingency		30%		\$ 54,566,000	
			TOTAL BUDGETARY CONSTRUCTION COST	\$ 280,107,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 56,021,400	I
			TOTAL BUDGETARY CAPITAL COST	\$ 336,128,000	

Table 10 below presents a summary of the Generic Pure Oxygen Activated Sludge Plant capital cost estimates for each effluent level, and the resulting capital costs on a \$/gpd basis utilizing the generic plant's annual average flow of 83 mgd.

Table 10: Generic Pure Oxygen Plant Summary of Capital Costs

Effluent Level	Capital Cost Estimate	\$/gpd of capacity
NH ₃ -N = 10 mg/L	\$80 million	1.0
NH ₃ -N = 5 mg/L	\$105 million	1.3
NH ₃ -N = 1.5 mg/L	\$134 million	1.6
TN = 4 mg/L	\$336 million	4.0

4.0 GENERIC FIXED FILM PLANT CAPITAL COST ESTIMATES

As described in the Generic Plant Descriptions Technical Memorandum dated July 19, 2019, the characteristics of the Generic Fixed Film Plant are listed in Table 11.

Table 11: Generic Fixed Film Plant Characteristics

Parameter	Value
Influent Annual Average Flow	9 mgd
Influent Maximum Monthly (30-day average) Flow	11 mgd
Influent Maximum Daily (24-hour average) Flow	15 mgd
Influent Average BOD Concentration	270 mg/L
Influent Average TSS Concentration	250 mg/L
Influent Average NH ₃ -N Concentration	30 mg/L
Recycle Average Flow from Thickening and Dewatering	1 mgd
Recycle Flow Average BOD Concentration	800 mg/L
Recycle Flow Average TSS Concentration	500 mg/L
Recycle Flow Average NH ₃ -N Concentration	120 mg/L
Effluent Average BOD Concentration	19 mg/L
Effluent Average TSS Concentration	14 mg/L
Effluent Summer Max. Monthly Average NH ₃ -N Concentration	17 mg/L
Effluent Average NH ₃ -N Concentration	16 mg/L
Effluent Min. Monthly Summer Temperature (C)	18°

As further described in the Effluent Levels Technical Memorandum, the plant upgrade improvements will be sized to achieve the effluent levels each month of the summer season defined as May 1 through October 31, rather than each month of the year. Therefore, the

improvements for each effluent level will be sized for the maximum monthly average (i.e., maximum 30-day average flow) rather than the annual average flow and will be sized for the minimum temperature that occurs in the summer season rather than the minimum temperature that occurs in the winter. The resulting sizing criteria for the BAF process for the Generic Fixed Film Plant are summarized in Table 12.

Table 12: Generic Fixed Film Plant BAF Design/Sizing Criteria

Effluent Levels	BAF Influent NH ₃	BAF Influent BOD	Maximum Monthly Average Flow ⁽¹⁾	Minimum Monthly Avg Temperature	Required BAF Effluent NH ₃
10 mg/L NH ₃	16 mg/L	19 mg/L	5 mgd	18 deg C	1.5 mg/L
5 mg/L NH ₃	16 mg/L	19 mg/L	8 mgd	18 deg C	1.5 mg/L
1.5 mg/L NH ₃	16 mg/L	19 mg/L	11 mgd	18 deg C	1.5 mg/L

Similarly, the resulting sizing criteria for the Generic Fixed Film Plant denitrification filter are summarized in Table 13.

Table 13: Generic Fixed Film Plant Denitrification Filter Design/Sizing Criteria

Effluent Level	DF Influent NH ₃	DF Influent NO ₃	DF Influent BOD	Max. Monthly Average Flow ⁽¹⁾	Minimum Monthly Avg. Temperature	Required DF Effluent TN
4 mg/L TN	1.5 mg/L	15.5 mg/L	2 mg/L	11 mgd	18 deg C	4 mg/L

To support the addition of BAFs and a denitrification filter, the additional improvements presented in Table 14 have been included for the Generic Fixed Film Plant. These additional improvements will be modified as appropriate for the plant-specific cost estimates.

Table 14: Generic Fixed Film Plant – Related Additional Improvements

Scenario	Additional Improvements
NH ₃ -N – 10 mg/L	Intermediate Pump Station – 5 mgd firm capacity and TDH based on BAF headloss Alkalinity Storage and Feed System and new Chemical Building BAF Gallery Building and Backwash Pumping Station
NH ₃ -N – 5 mg/L	Intermediate Pump Station – 8 mgd firm capacity and TDH based on BAF headloss Alkalinity Storage and Feed System and new Chemical Building BAF Gallery Building and Backwash Pumping Station
NH ₃ -N – 1.5 mg/L	Intermediate Pump Station – 11 mgd firm capacity and TDH based on BAF headloss Alkalinity Storage and Feed System and new Chemical Building BAF Gallery Building and Backwash Pumping Station
TN – 4 mg/L	Intermediate Pump Station – 11 mgd firm capacity and TDH based on BAF + DF HL Alkalinity Storage and Feed System and new Chemical Building Methanol Storage and Feed System and new Chemical Building BAF Gallery Building and Backwash Pumping Station DF Gallery Building and Backwash Pumping Station

To aid in the understanding of the improvements to achieve the various effluent levels, Figure 4 in Appendix A presents a process flow diagram of the existing Generic Fixed Film Plant; Figure 5 depicts the improvements for the three (3) levels of NH₃-N reduction; and Figure 6 depicts the improvements for the effluent TN level of 4 mg/L.

The Generic Fixed Film Plant capital cost estimates for the four (4) effluent level scenarios follow.

Table 15: Generic Fixed Film Plant Capital Cost Estimate for NH₃-N of 10 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
5 MGD BAF System w/blowers and BW pumps	1	LS	\$ 3,500,000	\$ 3,500,000	Quote from Kruger
New BAF feed pumps	2	LS	\$ 65,000	\$ 130,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 36,000	\$ 36,000	Quote from PEP
Piping, valves and accessories @20%				\$ 733,200	
			<i>Subtotal</i>	\$ 4,399,200	
Installation		25%		\$ 1,099,800	
			<i>Major Equipment & Systems Subtotal</i>	\$ 5,499,000	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	170	CY	\$ 950	\$ 161,500	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	100	CY	\$ 600	\$ 60,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	880	CY	\$ 950	\$ 836,000	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	525	CY	\$ 600	\$ 315,000	Unit quote from similar project
Excavation/Backfill - BAF feed PS	870	CY	\$ 58	\$ 50,460	RSMeans 2019 Estimate
Excavation/Backfill - BAF System	1240	CY	\$ 58	\$ 71,920	RSMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
			<i>Unit Price & Other Item Subtotal</i>	\$ 1,694,880	
Buildings					
Chemical Building - (for alkalinity control)	800	SF	\$ 350	\$ 280,000	Complete with lighting and HVAC
BAF - Gallery Building	1500	SF	\$ 350	\$ 525,000	Complete with lighting and HVAC
BAF feed pump building	900	SF	\$ 350	\$ 315,000	Complete with lighting and HVAC
			<i>Buildings Subtotal</i>	\$ 1,120,000	
Bulk Work Percentage					
Civil Site		10%		\$ 831,000	
Electrical		20%		\$ 1,663,000	
Instrumentation & Controls		10%		\$ 831,000	
Yard Piping		15%		\$ 1,247,000	
			<i>Bulk Work Subtotal</i>	\$ 4,572,000	
Subtotal Direct Costs				\$ 12,886,000	Also includes General Conditions
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 3,093,000	
Contingency		30%		\$ 3,866,000	
TOTAL BUDGETARY CONSTRUCTION COST				\$ 19,845,000	
Engineering, Permitting, Legal, and Administration		15%		\$ 2,976,750	
TOTAL BUDGETARY CAPITAL COST				\$ 22,822,000	

Table 16: Generic Fixed Film Plant Capital Cost Estimate for NH₃-N of 5 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
8 MGD BAF System w/blowers and BW pumps	1	LS	\$ 4,300,000	\$ 4,300,000	Quote from Kruger
New BAF feed pumps	3	LS	\$ 45,000	\$ 135,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 43,500	\$ 43,500	Quote from PEP
Piping, valves and accessories @20%				\$ 895,700	
			<i>Subtotal</i>	\$ 5,374,200	
Installation		25%		\$ 1,343,550	
Major Equipment & Systems Subtotal				\$ 6,717,750	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	160	CY	\$ 950	\$ 152,000	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	100	CY	\$ 600	\$ 60,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	1000	CY	\$ 950	\$ 950,000	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	625	CY	\$ 600	\$ 375,000	Unit quote from similar project
Excavation/Backfill - BAF feed PS	750	CY	\$ 58	\$ 43,500	RSMMeans 2019 Estimate
Excavation/Backfill - BAF System	1580	CY	\$ 58	\$ 91,640	RSMMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
Unit Price & Other Item Subtotal				\$ 1,872,140	
Buildings					
Chemical Building - (for alkalinity control)	1125	SF	\$ 350	\$ 393,750	Complete with lighting and HVAC
BAF - Gallery Building	1500	SF	\$ 350	\$ 525,000	Complete with lighting and HVAC
BAF feed pump building	720	SF	\$ 350	\$ 252,000	Complete with lighting and HVAC
Buildings Subtotal				\$ 1,170,750	
Bulk Work Percentage					
Civil Site		10%		\$ 976,000	
Electrical		20%		\$ 1,952,000	
Instrumentation & Controls		10%		\$ 976,000	
Yard Piping		15%		\$ 1,464,000	
Bulk Work Subtotal				\$ 5,368,000	
Subtotal Direct Costs				\$ 15,129,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 3,631,000	Also includes General Conditions
Contingency		30%		\$ 4,539,000	
TOTAL BUDGETARY CONSTRUCTION COST				\$ 23,299,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 4,659,800	
TOTAL BUDGETARY CAPITAL COST				\$27,959,000	

Table 17: Generic Fixed Film Plant Capital Cost Estimate for NH₃-N of 1.5 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
11 MGD BAF System w/blowers and BW pumps	1	LS	\$ 5,000,000	\$ 5,000,000	Quote from Kruger
New BAF feed pumps	3	LS	\$ 65,000	\$ 195,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 51,000	\$ 51,000	Quote from PEP
Piping, valves and accessories @20%				\$ 1,049,200	
			<i>Subtotal</i>	\$ 6,295,200	
Installation		25%		\$ 1,573,800	
			<i>Major Equipment & Systems Subtotal</i>	7,869,000	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	225	CY	\$ 950	\$ 213,750	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	150	CY	\$ 600	\$ 90,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	1140	CY	\$ 950	\$ 1,083,000	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	745	CY	\$ 600	\$ 447,000	Unit quote from similar project
Excavation/Backfill - BAF feed PS	1250	CY	\$ 58	\$ 72,500	RSMeans 2019 Estimate
Excavation/Backfill - BAF System	1980	CY	\$ 58	\$ 114,840	RSMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
			<i>Unit Price & Other Item Subtotal</i>	2,221,090	
Buildings					
Chemical Building - (for alkalinity control)	1500	SF	\$ 350	\$ 525,000	Complete with lighting and HVAC
BAF - Gallery Building	1500	SF	\$ 350	\$ 525,000	Complete with lighting and HVAC
BAF feed pump building	1350	SF	\$ 350	\$ 472,500	Complete with lighting and HVAC
			<i>Buildings Subtotal</i>	1,522,500	
Bulk Work Percentage					
Civil Site		10%		\$ 1,161,000	
Electrical		20%		\$ 2,323,000	
Instrumentation & Controls		10%		\$ 1,161,000	
Yard Piping		15%		\$ 1,742,000	
			<i>Bulk Work Subtotal</i>	6,387,000	
Subtotal Direct Costs				\$ 18,000,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 4,320,000	Also includes General Conditions
Contingency		30%		\$ 5,400,000	
TOTAL BUDGETARY CONSTRUCTION COST				\$ 27,720,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 5,544,000	
TOTAL BUDGETARY CAPITAL COST				\$33,264,000	

Table 18: Generic Fixed Film Plant Capital Cost Estimate for TN of 4 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
11 MGD BAF System w/blowers and BW pumps	1	LS	\$ 5,000,000	\$ 5,000,000	Quote from Kruger
New BAF feed pumps	3	LS	\$ 65,000	\$ 195,000	Quote from ABS
Alkalinity Storage and Feed System	1	EA	\$ 51,000	\$ 51,000	Quote from PEP
New Denite filter feed pumps	3	LS	\$ 65,000	\$ 195,000	Quote from ABS
Denite filters w/BW pumps, blowers and methanol storage	1	LS	\$ 2,600,000	\$ 2,600,000	Quote from DeNora
Piping, valves and accessories @20%				\$ 1,608,200	
			<i>Subtotal</i>	\$ 9,649,200	
Installation		25%		\$ 2,412,300	
			Major Equipment & Systems Subtotal	12,061,500	
Unit Price & Other Items					
Cast in Place Conc. Walls - BAF feed PS	450	CY	\$ 950	\$ 427,500	Unit quote from similar project
Cast in Place Conc. Foundation - BAF feed PS	300	CY	\$ 600	\$ 180,000	Unit quote from similar project
Cast in Place Conc. Walls - BAF System	1140	CY	\$ 950	\$ 1,083,000	Unit quote from similar project
Cast in Place Conc. Foundation - BAF System	745	CY	\$ 600	\$ 447,000	Unit quote from similar project
Cast in Place Conc. Walls - Denite Filter	1970	CY	\$ 900	\$ 1,773,000	Unit quote from similar project
Cast in Place Conc. Foundation -Denite Filter	895	CY	\$ 600	\$ 537,000	Unit quote from similar project
Methanol Storage pad w/ containment	225	CY	\$ 600	\$ 135,000	Unit quote from similar project
Excavation/Backfill - BAF and Denite feed PS	2500	CY	\$ 58	\$ 145,000	RSMeans 2019 Estimate
Excavation/Backfill - BAF System	1980	CY	\$ 58	\$ 114,840	RSMeans 2019 Estimate
Excavation/Backfill - Denite Filter	930	CY	\$ 58	\$ 53,940	RSMeans 2019 Estimate
Excavation/Backfill - Methanol storage system	675	CY	\$ 58	\$ 39,150	RSMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	
			Unit Price & Other Item Subtotal	5,135,430	
Buildings					
Chemical Building - (for alkalinity control)	1500	SF	\$ 350	\$ 525,000	Complete with lighting and HVAC
BAF - Gallery Building	1500	SF	\$ 350	\$ 525,000	Complete with lighting and HVAC
Denitrification Filter - Gallery Building	2000	SF	\$ 350	\$ 700,000	Complete with lighting and HVAC
BAF and Denite feed pump building	2700	SF	\$ 350	\$ 945,000	Complete with lighting and HVAC
			Buildings Subtotal	\$ 2,695,000	
Bulk Work Percentage					
Civil Site		10%		\$ 1,989,000	
Electrical		20%		\$ 3,978,000	
Instrumentation & Controls		10%		\$ 1,989,000	
Yard Piping		15%		\$ 2,984,000	
			Bulk Work Subtotal	10,940,000	
Subtotal Direct Costs				\$ 30,832,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 7,400,000	Also includes General Conditions
Contingency		30%		\$ 9,250,000	
TOTAL BUDGETARY CONSTRUCTION COST				\$ 47,482,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 9,496,400	
TOTAL BUDGETARY CAPITAL COST				\$56,978,000	

Table 19 presents a summary of the Generic Fixed Film Plant capital cost estimates for each effluent level, and the resulting capital costs on a \$/gpd basis utilizing the Generic Fixed Film Plant's annual average flow of 9 mgd.

Table 19: Generic Fixed Film Plant Summary of Capital Costs

Effluent Level	Capital Cost Estimate	\$/gpd of capacity
NH ₃ -N = 10 mg/L	\$23 million	2.5
NH ₃ -N = 5 mg/L	\$28 million	3.1
NH ₃ -N = 1.5 mg/L	\$33 million	3.7
TN = 4 mg/L	\$57 million	6.3

5.0 GENERIC CONVENTIONAL ACTIVATED SLUDGE PLANT CAPITAL COST ESTIMATES

As described in the Generic Plant Descriptions Technical Memorandum dated July 19, 2019, the characteristics of the Generic Conventional Activated Sludge Plant (also referred to as the Generic Conventional Plant) are listed in the table below.

Table 20: Generic Conventional Activated Sludge Plant Characteristics

Parameter	Value
Influent Annual Average Flow	72 mgd
Influent Maximum Monthly (30-day average) Flow	87 mgd
Influent Maximum Daily (24-hour average) Flow	163 mgd
Influent Average CBOD Concentration	240 mg/L
Influent Average TSS Concentration	220 mg/L
Influent Average NH ₃ -N Concentration	25 mg/L
Primary Effluent Average Flow	79 mgd
Primary Effluent Average CBOD Concentration	200 mg/L
Primary Effluent Average TSS Concentration	150 mg/L
Primary Effluent Average NH ₃ -N Concentration.	33 mg/L
Recycle Average Flow from Thickening and Dewatering	7 mgd
Recycle Flow Average CBOD Concentration	800 mg/L
Recycle Flow Average TSS Concentration	500 mg/L
Recycle Flow Average NH ₃ -N Concentration	120 mg/L
Effluent Average CBOD Concentration	7 mg/L
Effluent Average TSS Concentration	9 mg/L
Effluent Summer Max. Monthly Average NH ₃ -N Concentration	18 mg/L

Effluent Average NH ₃ -N Concentration	10 mg/L
Effluent Min. Monthly Summer Temperature (C)	18°

As further described in the Effluent Levels Technical Memorandum, the plant upgrade improvements will be sized to achieve the effluent levels each month of the summer season defined as May 1 through October 31, rather than each month of the year. Therefore, the improvements for each effluent level will be sized for the maximum monthly average (i.e., maximum 30-day average flow) rather than the annual average flow and will be sized for the minimum temperature that occurs in the summer season rather than the minimum temperature that occurs in the winter. The resulting sizing criteria for integrated fixed film activated sludge (IFAS) process applicable to two (2) of the three (3) effluent NH₃-N levels are summarized in Table 21 below.

Table 21: Generic Conventional Activated Sludge Plant IFAS Design/Sizing Criteria

Effluent Level	Current Effluent NH ₃	Current Effluent BOD	Current MLSS	Max. Monthly Average Flow ¹	Minimum Monthly Avg. Temperature	Required Effluent NH ₃
5 mg/L NH ₃	10 mg/L	7 mg/L	3,000 mg/L	87 mgd	18 deg C	5 mg/L
1.5 mg/L NH ₃	10 mg/L	7 mg/L	3,000 mg/L	87 mgd	18 deg C	1.5 mg/L

Unlike the Generic Pure Oxygen Activated Sludge and Fixed Film Plants, which utilize add-on processes downstream of the existing plant to achieve the various effluent levels, improvements to the Generic Conventional Activated Sludge Plant to achieve the three effluent levels are integrated with, rather than an added downstream of, the plant. Therefore, the number and size of the Generic Conventional Activated Sludge Plant's aeration basins and final clarifiers is relevant to the improvements required and the corresponding budgetary capital cost estimates.

In this regard, the Generic Conventional Activated Sludge Plant has a total of six (6) aeration basins, each with a volume of approximately 2.4 million gallons, and four (4) final clarifiers, each with a diameter of 140 feet.

The sizing criteria for the Generic Conventional Activated Sludge Plant's denitrification filter are summarized in Table 22.

Table 22: Generic Conventional Plant Denitrification Filter Design/Sizing Criteria

Effluent Level	DF Influent NH ₃	DF Influent NO ₃	DF Influent BOD	Max Monthly Average Flow ⁽¹⁾	Minimum Monthly Avg Temperature	Required DF Effluent TN
4 mg/L TN	1.5 mg/L	16.5 mg/L	2 mg/L	11 mgd	18 deg C	4 mg/L

The improvements recommended to achieve the 10 mg/L effluent NH₃-N level, and the improvements to support the IFAS process and denitrification filter, are listed in Table 23. These additional improvements will be modified as appropriate for the plant-specific cost estimates.

Table 23: Generic Conventional Plant – Related Additional Improvements

Effluent Level	Additional Improvements
NH ₃ -N – 10 mg/L	Modify the existing blowers and ceramic disc diffusers to supply additional air to meet the oxygen demand associated with removing NH ₃ -N to 10 mg/L Construction of two (2) additional 140-foot-diameter final clarifiers to reduce the SOR for partial nitrification Increase RAS pumping capacity to be able to return sludge at 75% during maximum monthly average flow
NH ₃ -N – 5 mg/L	Additional Blowers and new Blower Building Replacement of RAS Pumps with new Higher Capacity Pumps Alkalinity Storage and Feed System and new Chemical Building Structural Modifications to Existing Aeration Tanks
NH ₃ -N – 1.5 mg/L	Additional Blowers and new Blower Building Replacement of RAS Pumps with new Higher Capacity Pumps Alkalinity Storage and Feed System and new Chemical Building Structural Modifications to Existing Aeration Tanks
TN – 4 mg/L	Additional Blowers and new Blower Building Replacement of RAS Pump with new Higher Capacity Pumps Structural Modifications to Existing Aeration Tanks Intermediate Pump Station – 87 mgd firm capacity and TDH based on DF HL Alkalinity Storage and Feed System and new Chemical Building Methanol Storage and Feed System and new Chemical Building DF Gallery Building and Backwash Pumping Station

To aid in the understanding of the improvements to achieve the various effluent levels, Figure 7 in Appendix A presents a process flow diagram of the existing Generic Conventional Activated Sludge Plant; Figure 8 depicts the improvements for the NH₃-N effluent level of 10 mg/L; Figure

9 depicts the improvements for the NH₃-N effluent levels of 5 mg/L and 1.5 mg/L; and Figure 10 presents the improvements for the effluent TN level of 4 mg/L.

The Generic Conventional Plant capital cost estimates for the four (4) effluent level scenarios follow.

Table 24: Generic Conventional Plant Capital Cost Estimate for NH₃-N of 10 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
New ceramic finebubble diffusers for additional nitrification	1	LS	\$ 600,000	\$ 600,000	Quote from Sanitaire
New 140' dia. Final Clarifier collector w/ density current baffle	2	EA	\$ 380,000	\$ 760,000	Quote from Envirodyne
New Blowers Process Air System	2	EA	\$ 622,000	\$ 1,244,000	Quote from Turblex
New RAS Pumps	3	EA	\$ 180,000	\$ 540,000	Quote from Sultz
Mag Storage and Feed System for alkalinity control	1	EA	\$ 248,000	\$ 248,000	4X10000 gallons double contained HDPE tanks
Piping, valves and accessories @20%				\$ 678,400	
			<i>Subtotal</i>	\$ 4,070,400	
Installation		25%		\$ 1,017,600	
			Major Equipment & Systems Subtotal	\$ 5,088,000	
Unit Price & Other Items					
Cast in Place Conc. Walls - Final Clarifiers	1270	CY	\$ 950	\$ 1,206,500	Unit quote from similar project
Cast in Place Conc. Foundation - Final Clarifiers	2880	CY	\$ 600	\$ 1,728,000	Unit quote from similar project
Cast in Place Conc. Walls - RAS Bldg	169	CY	\$ 950	\$ 160,550	Unit quote from similar project
Cast in Place Conc. Foundation - RAS Bldg	194	CY	\$ 600	\$ 116,400	Unit quote from similar project
Excavation/Backfill - New Final Clarifiers	16380	CY	\$ 58	\$ 950,040	RSMMeans 2019 Estimate
Excavation/Backfill - RAS Building	1142	CY	\$ 58	\$ 66,236	RSMMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 100,000	\$ 100,000	KLF Estimate
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	KLF Estimate
			Unit Price & Other Item Subtotal	\$ 4,427,726	
Buildings					
Chemical Building - (for alkalinity control)	2250	SF	\$ 350	\$ 787,500	Complete with lighting and HVAC
RAS Building	2625	SF	\$ 350	\$ 918,750	Complete with lighting and HVAC
Blower Building	2700	SF	\$ 350	\$ 945,000	Complete with lighting and HVAC
			Buildings Subtotal	\$ 2,651,250	
Bulk Work Percentage					
Civil Site		10%		\$ 1,217,000	
Electrical		20%		\$ 2,433,000	
Instrumentation & Controls		10%		\$ 1,217,000	
Yard Piping		15%		\$ 1,825,046	
			Bulk Work Subtotal	\$ 6,692,046	
			Subtotal Direct Costs	\$ 18,859,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 4,526,000	Also includes General Conditions
Contingency		30%		\$ 5,658,000	
			TOTAL BUDGETARY CONSTRUCTION COST	\$ 29,043,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 5,808,600	
			TOTAL BUDGETARY CAPITAL COST	\$ 34,852,000	

Table 25: Generic Conventional Plant Capital Cost Estimate for NH₃-N of 5 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
New 1/4-inch raw WW influent screen w/washer-compactor	1	LS	\$ 725,000	\$ 725,000	Quote from Duperon
IFAS System w/floating media, diffusers and screens	1	LS	\$ 9,990,000	\$ 9,990,000	Quote from Kruger
New 140' dia. Final Clarifier collector w/ density current baffle	2	EA	\$ 380,000	\$ 760,000	Quote from Envirodyne
New Blowers Process Air System	6	EA	\$ 622,000	\$ 3,732,000	Quote from Turblex
New RAS Pumps	3	EA	\$ 180,000	\$ 540,000	Quote from Sultzter
Mag Storage and Feed System for alkalinity control	1	EA	\$ 365,000	\$ 365,000	6X10000 gallons double contained HDPE tanks
Piping, valves and accessories @20%				\$ 3,222,400	
			<i>Subtotal</i>	\$ 19,334,400	
Installation		25%		\$ 4,833,600	
			Major Equipment & Systems Subtotal	24,168,000	
Unit Price & Other Items					
Cast in Place Conc. - Modification to Aeration tank	3230	CY	\$ 2,000	\$ 6,460,000	complicated structural modifications
Cast in Place Conc. Walls - Final Clarifiers	1270	CY	\$ 950	\$ 1,206,500	Unit quote from similar project
Cast in Place Conc. Foundation - Final Clarifiers	2880	CY	\$ 600	\$ 1,728,000	Unit quote from similar project
Cast in Place Conc. Walls - RAS Bldg	169	CY	\$ 950	\$ 160,550	Unit quote from similar project
Cast in Place Conc. Foundation - RAS Bldg	194	CY	\$ 600	\$ 116,400	Unit quote from similar project
Excavation/Backfill - New Final Clarifiers	16380	CY	\$ 58	\$ 950,040	RSMeans 2019 Estimate
Excavation/Backfill - RAS Building	1142	CY	\$ 58	\$ 66,236	RSMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 200,000	\$ 200,000	KLF Estimate
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	KLF Estimate
			Unit Price & Other Item Subtotal	10,987,726	
Buildings					
Chemical Building - (for alkalinity control)	3300	SF	\$ 350	\$ 1,155,000	Complete with lighting and HVAC
RAS Building	2625	SF	\$ 350	\$ 918,750	Complete with lighting and HVAC
Blower Building	6300	SF	\$ 350	\$ 2,205,000	Complete with lighting and HVAC
			Buildings Subtotal	\$ 4,278,750	
Bulk Work Percentage					
Civil Site		10%		\$ 3,943,000	
Electrical		20%		\$ 7,887,000	
Instrumentation & Controls		10%		\$ 3,943,000	
Yard Piping		15%		\$ 5,915,171	
			Bulk Work Subtotal	21,688,171	
			Subtotal Direct Costs	\$ 61,123,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 14,670,000	Also includes General Conditions
Contingency		30%		\$ 18,337,000	
			TOTAL BUDGETARY CONSTRUCTION COST	\$ 94,130,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 18,826,000	
			TOTAL BUDGETARY CAPITAL COST	\$112,956,000	

Table 26: Generic Conventional Plant Capital Cost Estimate for NH₃-N of 1.5 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
New 1/4-inch raw WW influent screen w/washer-compactor	1	LS	\$ 725,000	\$ 725,000	Quote from Duperon
IFAS System w/floating media, diffusers and screens	1	LS	\$ 13,800,000	\$ 13,800,000	Quote from Kruger
New 140' dia. Final Clarifier collector w/ density current baffle	2	EA	\$ 380,000	\$ 760,000	Quote from Envirodyne
New Blowers Process Air System	6	EA	\$ 622,000	\$ 3,732,000	Quote from Turblex
New RAS Pumps	3	EA	\$ 180,000	\$ 540,000	Quote from Sulzer
Mag Storage and Feed System for alkalinity control	1	EA	\$ 420,000	\$ 420,000	7X10000 gallons double contained HDPE tank
Piping, valves and accessories @20%				\$ 3,995,400	
			<i>Subtotal</i>	\$ 23,972,400	
Installation		25%		\$ 5,993,100	
			Major Equipment & Systems Subtotal	29,965,500	
Unit Price & Other Items					
Cast in Place Conc. - Modification to Aeration tank	3230	CY	\$ 2,000	\$ 6,460,000	complicated structural modifications
Cast in Place Conc. Walls - Final Clarifiers	1270	CY	\$ 950	\$ 1,206,500	Unit quote from similar project
Cast in Place Conc. Foundation - Final Clarifiers	2880	CY	\$ 600	\$ 1,728,000	Unit quote from similar project
Cast in Place Conc. Walls - RAS Bldg	169	CY	\$ 950	\$ 160,550	Unit quote from similar project
Cast in Place Conc. Foundation - RAS Bldg	194	CY	\$ 600	\$ 116,400	Unit quote from similar project
Excavation/Backfill - New Final Clarifiers	16380	CY	\$ 58	\$ 950,040	RSMMeans 2019 Estimate
Excavation/Backfill - RAS Building	1142	CY	\$ 58	\$ 66,236	RSMMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 200,000	\$ 200,000	KLF Estimate
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	KLF Estimate
			Unit Price & Other Item Subtotal	10,987,726	
Buildings					
Chemical Building - (for alkalinity control)	3750	SF	\$ 350	\$ 1,312,500	Complete with lighting and HVAC
RAS Building	2625	SF	\$ 350	\$ 918,750	Complete with lighting and HVAC
Blower Building	6300	SF	\$ 350	\$ 2,205,000	Complete with lighting and HVAC
			Buildings Subtotal	4,436,250	
Bulk Work Percentage					
Civil Site		10%		\$ 4,539,000	
Electrical		20%		\$ 9,078,000	
Instrumentation & Controls		10%		\$ 4,539,000	
Yard Piping		15%		\$ 6,808,421	
			Bulk Work Subtotal	24,964,421	
			Subtotal Direct Costs	\$ 70,354,000	Also includes General Conditions
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 16,885,000	
Contingency		30%		\$ 21,106,000	
			TOTAL BUDGETARY CONSTRUCTION COST	\$ 108,345,000	
Engineering, Permitting, Legal, and Administration		20%		\$ 21,669,000	
			TOTAL BUDGETARY CAPITAL COST	\$130,014,000	

Table 27: Generic Conventional Plant Capital Cost Estimate for TN of 4 mg/L

<i>Item/Description</i>	<i>Quantity</i>	<i>Unit/Basis</i>	<i>Unit Budgetary Cost</i>	<i>Item Budgetary Cost</i>	<i>Comments</i>
Major Equipment & Systems					
New 1/4-inch raw WW influent screen w/washer-compactor	1	LS	\$ 725,000	\$ 725,000	Quote from Duperon
IFAS System w/floating media, diffusers and screens	1	LS	\$ 13,800,000	\$ 13,800,000	Quote from Kruger
New 140' dia. Final Clarifier drive mechanism w/DCB	2	EA	\$ 380,000	\$ 760,000	Quote from Envirodyne
New Blowers Process Air System	6	EA	\$ 622,000	\$ 3,732,000	Quote from Turblex
New RAS Pumps	3	EA	\$ 180,000	\$ 540,000	Quote from Sulzer
Mag Storage and Feed System for alkalinity control	1	EA	\$ 420,000	\$ 420,000	7X10000 gallons double contained HDPE tanks
New Denite filter w/BW pump, blowers and methanol storage	1	LS	\$ 18,000,000	\$ 18,000,000	Quote from DeNora
Dnite filter feed pumps	4	EA	\$ 190,000	\$ 760,000	Quote from ABS
Piping, valves and accessories @20%				\$ 7,747,400	
			<i>Subtotal</i>	\$ 46,484,400	
Installation		25%		\$ 11,621,100	
Major Equipment & Systems Subtotal				\$8,105,500	
Unit Price & Other Items					
Cast in Place Conc. - Modification to Aeration tank	3230	CY	\$ 2,000	\$ 6,460,000	complicated structural modifications
Cast in Place Conc. Walls - Final Clarifiers	1270	CY	\$ 900	\$ 1,143,000	Unit quote from similar project
Cast in Place Conc. Foundation - Final Clarifiers	2880	CY	\$ 600	\$ 1,728,000	Unit quote from similar project
Cast in Place Conc. Walls - RAS Bldg	169	CY	\$ 900	\$ 152,100	Unit quote from similar project
Cast in Place Conc. Foundation - RAS Bldg	194	CY	\$ 600	\$ 116,400	Unit quote from similar project
Cast in Place Conc. Foundation - PS w/ valve chamber + Dnite filter	5220	CY	\$ 600	\$ 3,132,000	Unit quote from similar project
Cast in Place Conc. Walls - PS w/ valve chamber + Dnite filter	9945	CY	\$ 900	\$ 8,950,500	Unit quote from similar project
Methanol Storage pad w/ containment	850	CY	\$ 600	\$ 510,000	Unit quote from similar project
Excavation/Backfill - New Final Clarifiers	16380	CY	\$ 58	\$ 950,040	RSMMeans 2019 Estimate
Excavation/Backfill - RAS Building	1142	CY	\$ 58	\$ 66,236	RSMMeans 2019 Estimate
Excavation/Backfill - Denitrification Filter + Dnite feed PS	8069	CY	\$ 58	\$ 468,002	RSMMeans 2019 Estimate
Excavation/Backfill - Methanol storage system	3000	CY	\$ 58	\$ 174,000	RSMMeans 2019 Estimate
Misc. Conc. Repair	1	LS	\$ 200,000	\$ 200,000	KLF Estimate
Misc. metal (grating, platforms, and stairs)	1	LS	\$ 100,000	\$ 100,000	KLF Estimate
Unit Price & Other Item Subtotal				\$24,150,278	
Buildings					
Chemical Building - (for alkalinity control)	3750	SF	\$ 350	\$ 1,312,500	Complete with lighting and HVAC
RAS Building	2625	SF	\$ 350	\$ 918,750	Complete with lighting and HVAC
Denitrification Filter - Gallery Building	2000	SF	\$ 350	\$ 700,000	Complete with lighting and HVAC
Denite feed PS building	3375	SF	\$ 350	\$ 1,181,250	Complete with lighting and HVAC
Blower Building	6300	SF	\$ 350	\$ 2,205,000	Complete with lighting and HVAC
Buildings Subtotal				\$6,317,500	
Bulk Work Percentage					
Civil Site		10%		\$ 8,857,000	
Electrical		20%		\$ 17,715,000	
Instrumentation & Controls		10%		\$ 8,857,000	
Yard Piping		15%		\$ 13,285,992	
Bulk Work Subtotal				\$48,714,992	
Subtotal Direct Costs				\$ 137,288,000	
CG OH&P with Bonds, Insurance, Mobilization/Demobilization		24%		\$ 32,949,000	
Contingency		30%		\$ 41,186,000	
TOTAL BUDGETARY CONSTRUCTION COST				\$ 211,423,000	
Engineering, Permitting, Legal, and Administration		15%		\$ 31,713,450	
TOTAL BUDGETARY CAPITAL COST				\$243,136,000	

Table 28 presents a summary of the Generic Conventional Activated Sludge Plant capital cost estimates for each effluent level, and the corresponding capital cost on a \$/gpd basis utilizing the Generic Conventional Plant's annual average flow of 72 mgd.

Table 28: Generic Conventional Activated Sludge Plant Summary of Capital Costs

Effluent Level	Capital Cost Estimate	\$/gpd of capacity
NH ₃ -N = 10 mg/L	\$35 million	0.5
NH ₃ -N = 5 mg/L	\$113 million	1.6
NH ₃ -N = 1.5 mg/L	\$130 million	1.8
TN = 4 mg/L	\$243 million	3.4

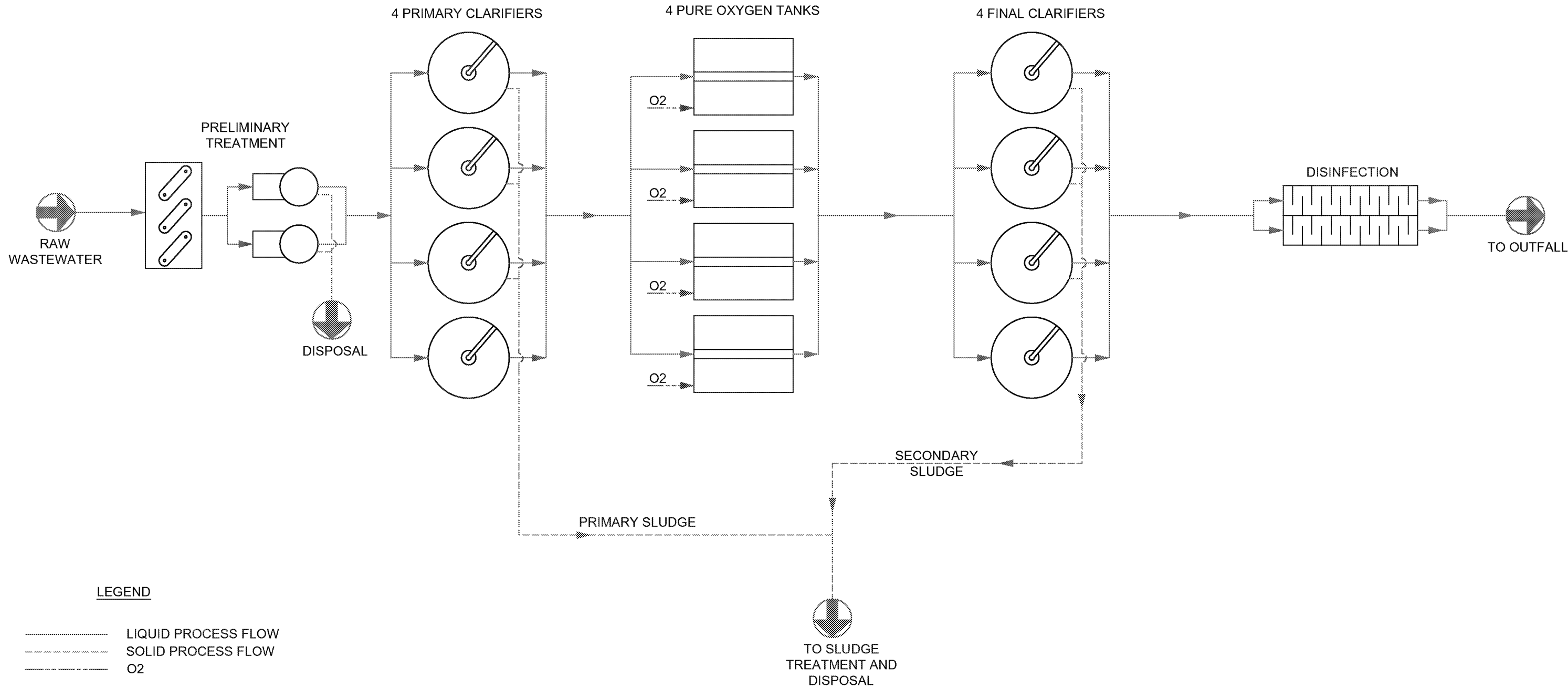
6.0 SUMMARY OF GENERIC PLANT CAPITAL COST ESTIMATES

Table 29 presents a summary of the capital cost estimates and corresponding cost on a \$/gpd basis for each generic plant at each effluent level.

Table 29: Summary of Generic Plan Capital Costs

Effluent Level	Capital Cost Estimate	\$/gpd of capacity
<i>Generic Pure Oxygen Activated Sludge Plant (Avg Flow: 83 mgd)</i>		
NH ₃ -N = 10 mg/L	\$80 million	1.0
NH ₃ -N = 5 mg/L	\$105 million	1.3
NH ₃ -N = 1.5 mg/L	\$134 million	1.6
TN = 4 mg/L	\$336 million	4.0
<i>Generic Fixed Film Plant (Avg Flow: 9 mgd)</i>		
NH ₃ -N = 10 mg/L	\$23 million	2.5
NH ₃ -N = 5 mg/L	\$28 million	3.1
NH ₃ -N = 1.5 mg/L	\$33 million	3.7
TN = 4 mg/L	\$57 million	6.3
<i>Generic Conventional Activated Sludge Plant (Avg Flow: 72 mgd)</i>		
NH ₃ -N = 10 mg/L	\$35 million	0.5
NH ₃ -N = 5 mg/L	\$113 million	1.6
NH ₃ -N = 1.5 mg/L	\$130 million	1.8
TN = 4 mg/L	\$243 million	3.4

Appendix A
Generic Plant Conceptual Process Flow Diagrams

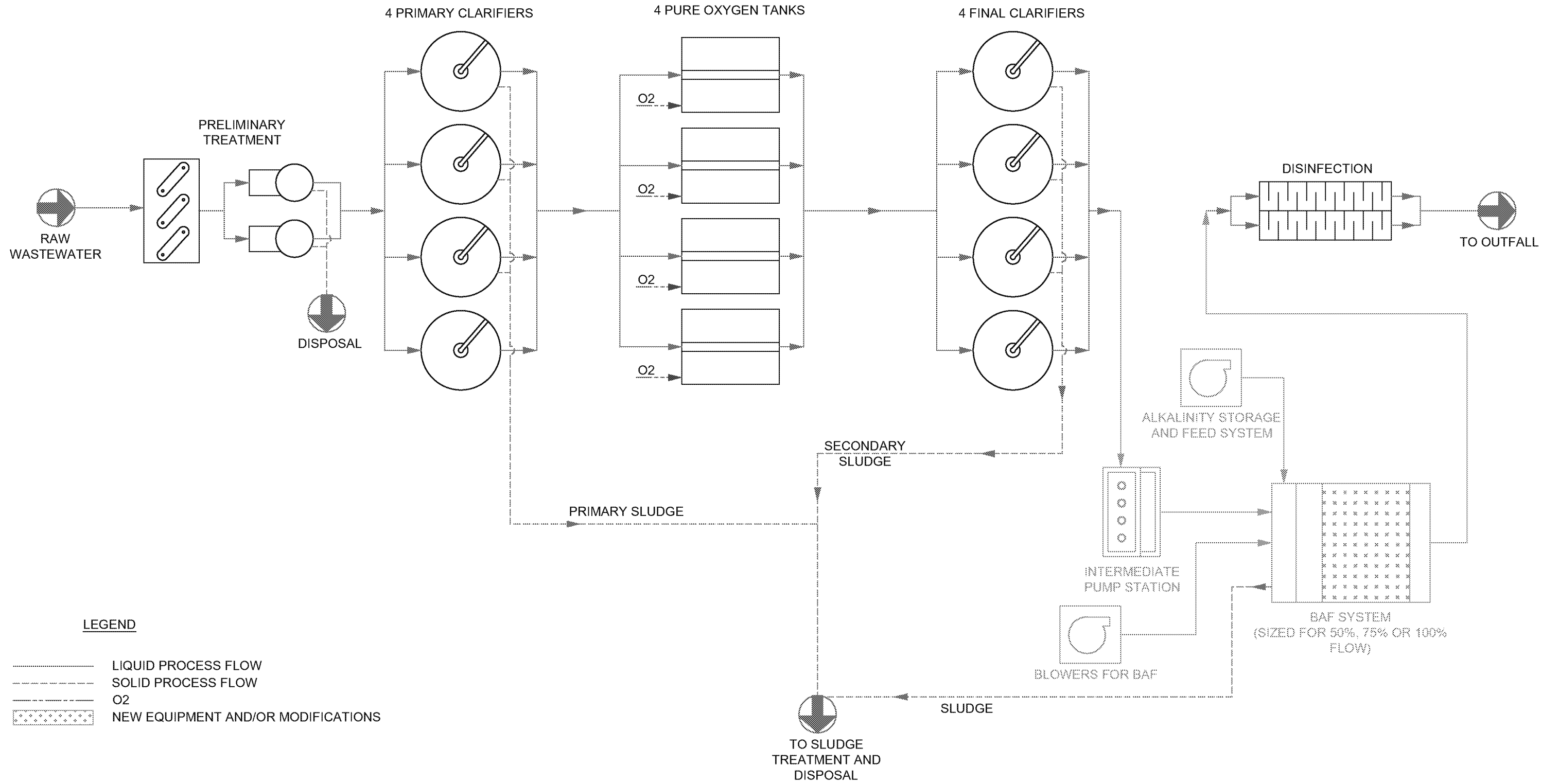


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PROJECT NO.	6736	GENERIC PURE OXYGEN ACTIVATED SLUDGE PLANT EXISTING CONDITIONS	FIGURE 1
DRAWN BY	ELD		
CHECKED BY	TKR	DRBC NITROGEN REDUCTION COST ESTIMATION STUDY	
DATE:	09-10-19		
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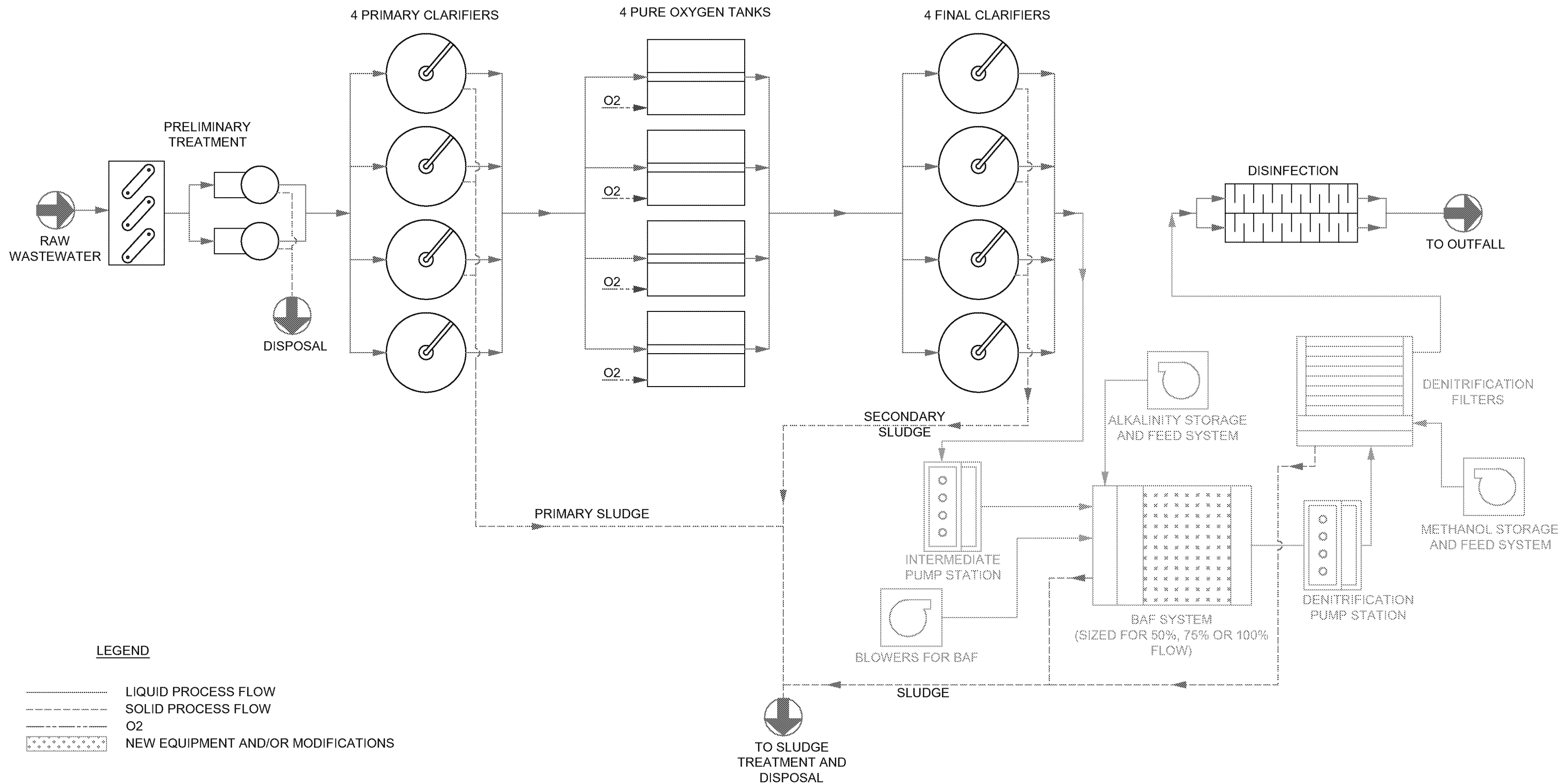
CAD FILE: S:\6736 - DRBC Cost Study\DWG\6736_PFDs.dwg LAYOUT: Pure Oxygen NH3 PLOTTED: 10/22/2019 5:33 PM BY: erin dovel



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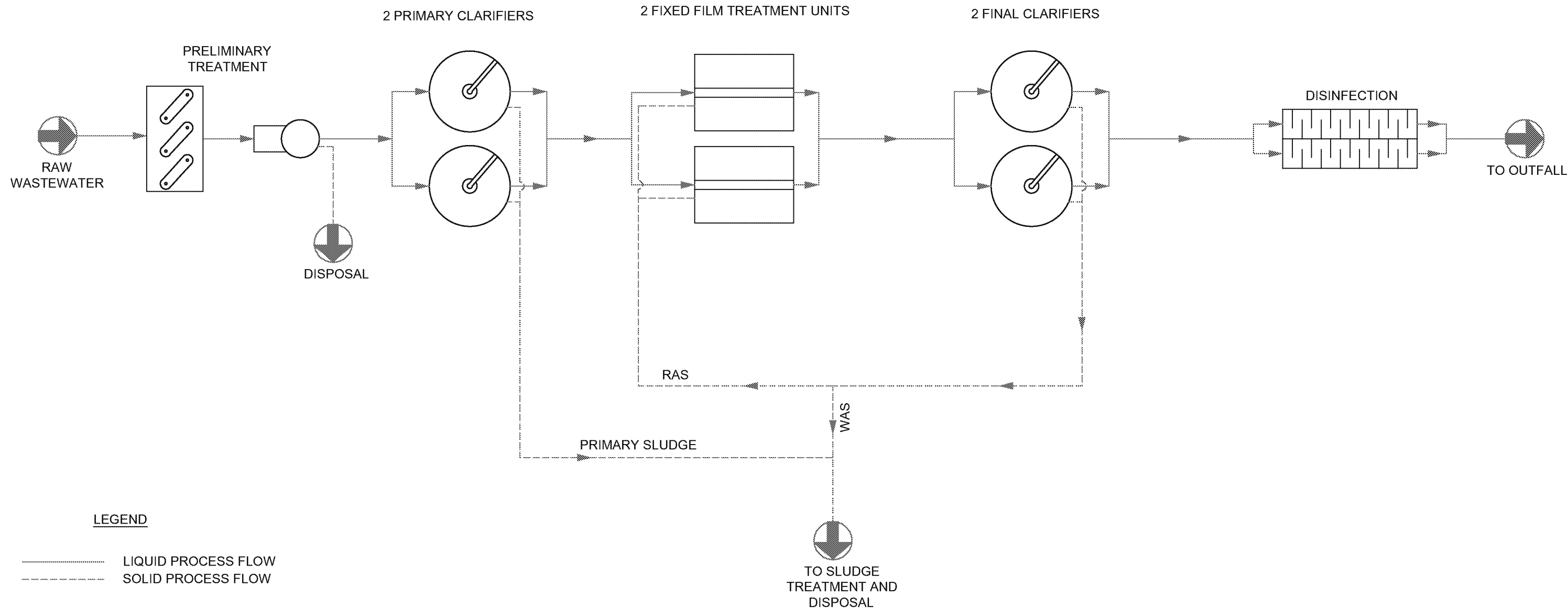
PROJECT NO.	6736	GENERIC PURE OXYGEN ACTIVATED SLUDGE PLANT NH3 10, 5, OR 1.5 MG/L	FIGURE 2
DRAWN BY	ELD		
CHECKED BY	TKR	DRBC NITROGEN REDUCTION COST ESTIMATION STUDY	
DATE:	09-10-19		
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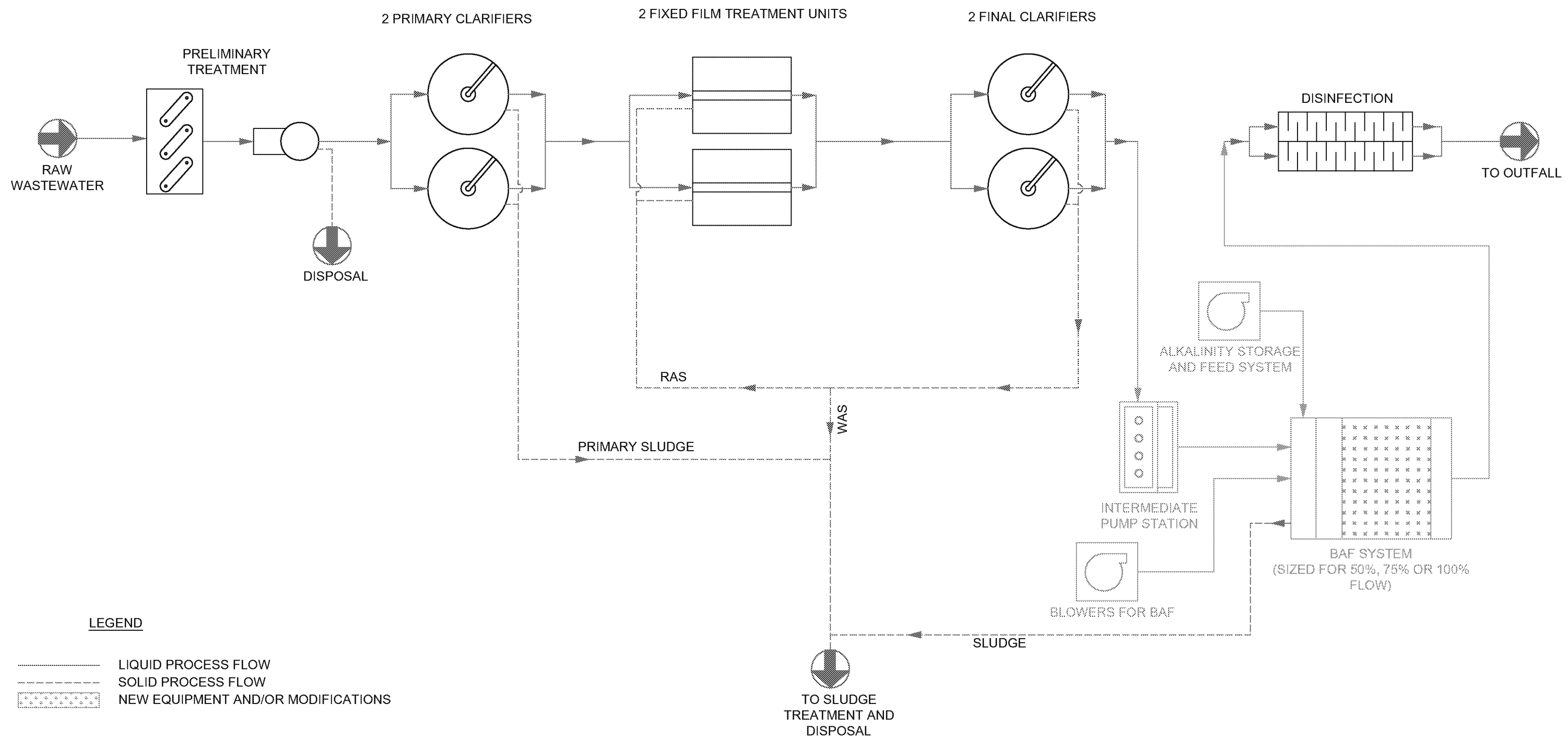
PROJECT NO.	6736	GENERIC PURE OXYGEN ACTIVATED SLUDGE PLANT NH ₃ - 1.5 MG/L AND TN - 4 MG/L	FIGURE 3
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PROJECT NO.	6736	GENERIC FIXED FILM ACTIVATED SLUDGE PLANT EXISTING CONDITIONS	FIGURE 4
DRAWN BY	ELD		
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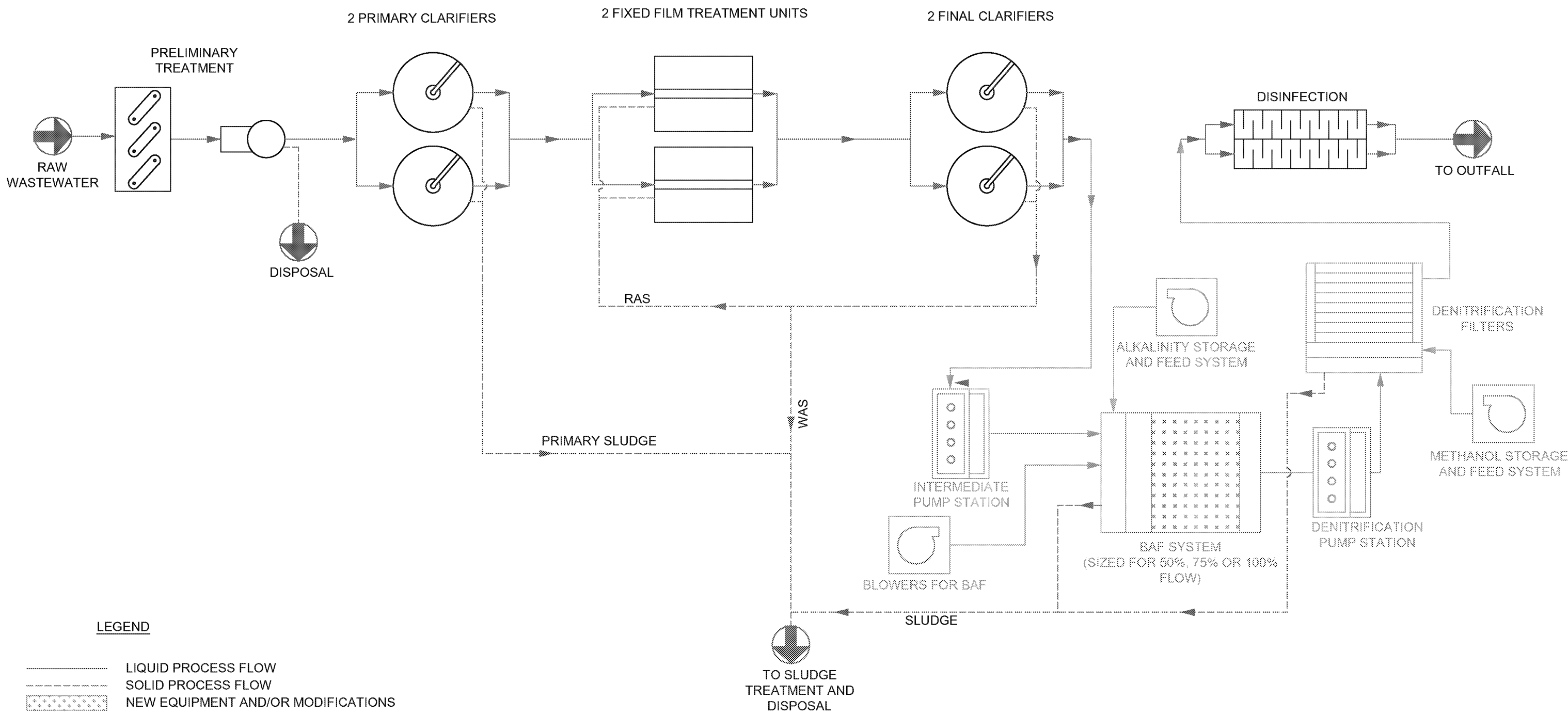


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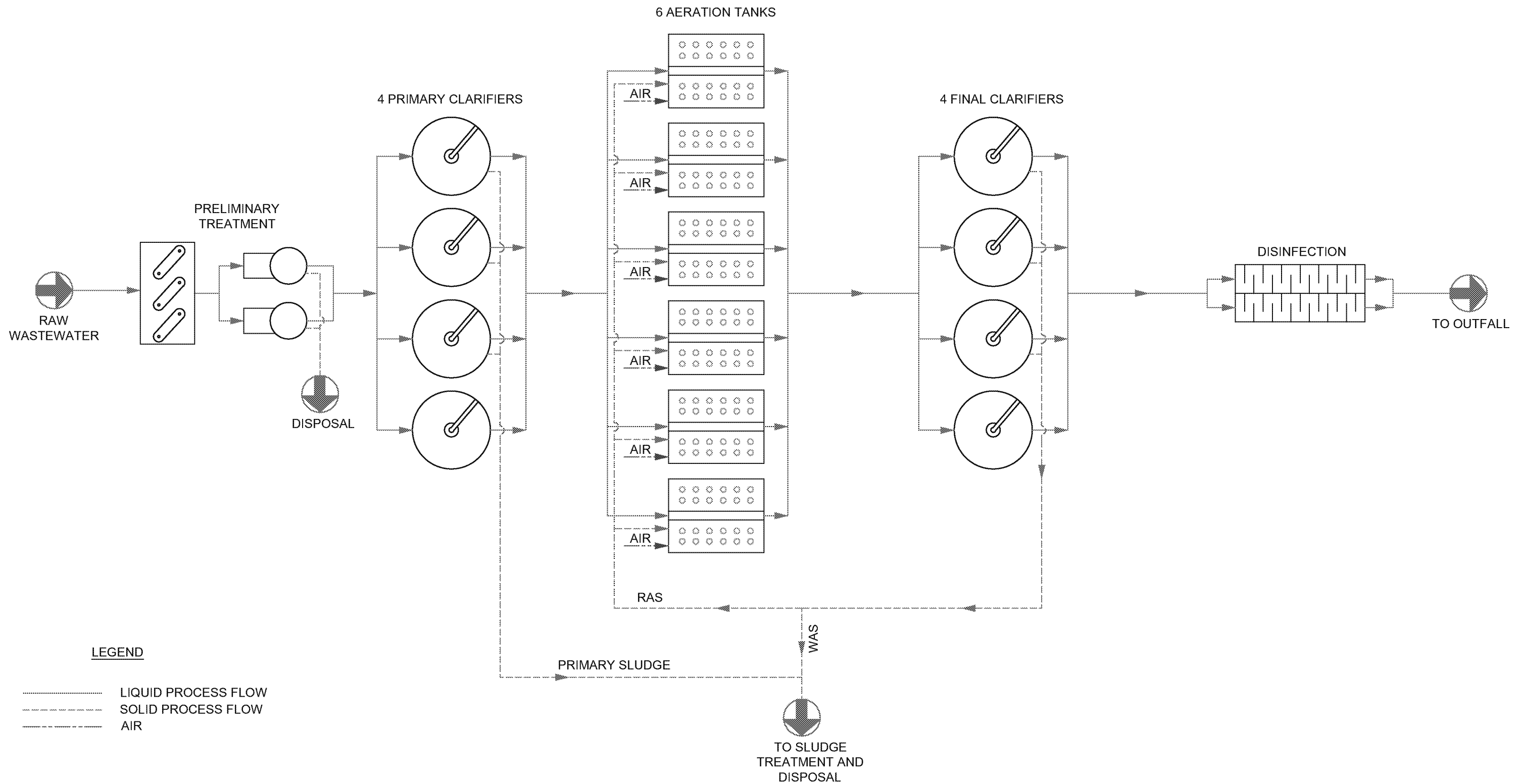
PROJECT NO.	6736	GENERIC FIXED FILM ACTIVATED SLUDGE PLANT NH3 - 10, 5, OR 1.5 MG/L	FIGURE 5
DRAWN BY	ELD		
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DATE:	09-10-19		
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CAD FILE: S:\6736 - DRBC Cost Study\DWG\6736_PFDs.dwg LAYOUT: Fixed Film NH3.tn PLOTTED: 10/22/2019 5:33 PM BY: erin dovel



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 KLEINFELDER <i>Bright People. Right Solutions.</i>	PROJECT NO.	6736	GENERIC FIXED FILM ACTIVATED SLUDGE PLANT NH3 - 1.5 MG/L AND TN - 4 MG/L	FIGURE 6
	DRAWN BY	ELD		
	CHECKED BY	TKR	DRBC	
	DATE:	09-10-19	NITROGEN REDUCTION COST ESTIMATION STUDY	
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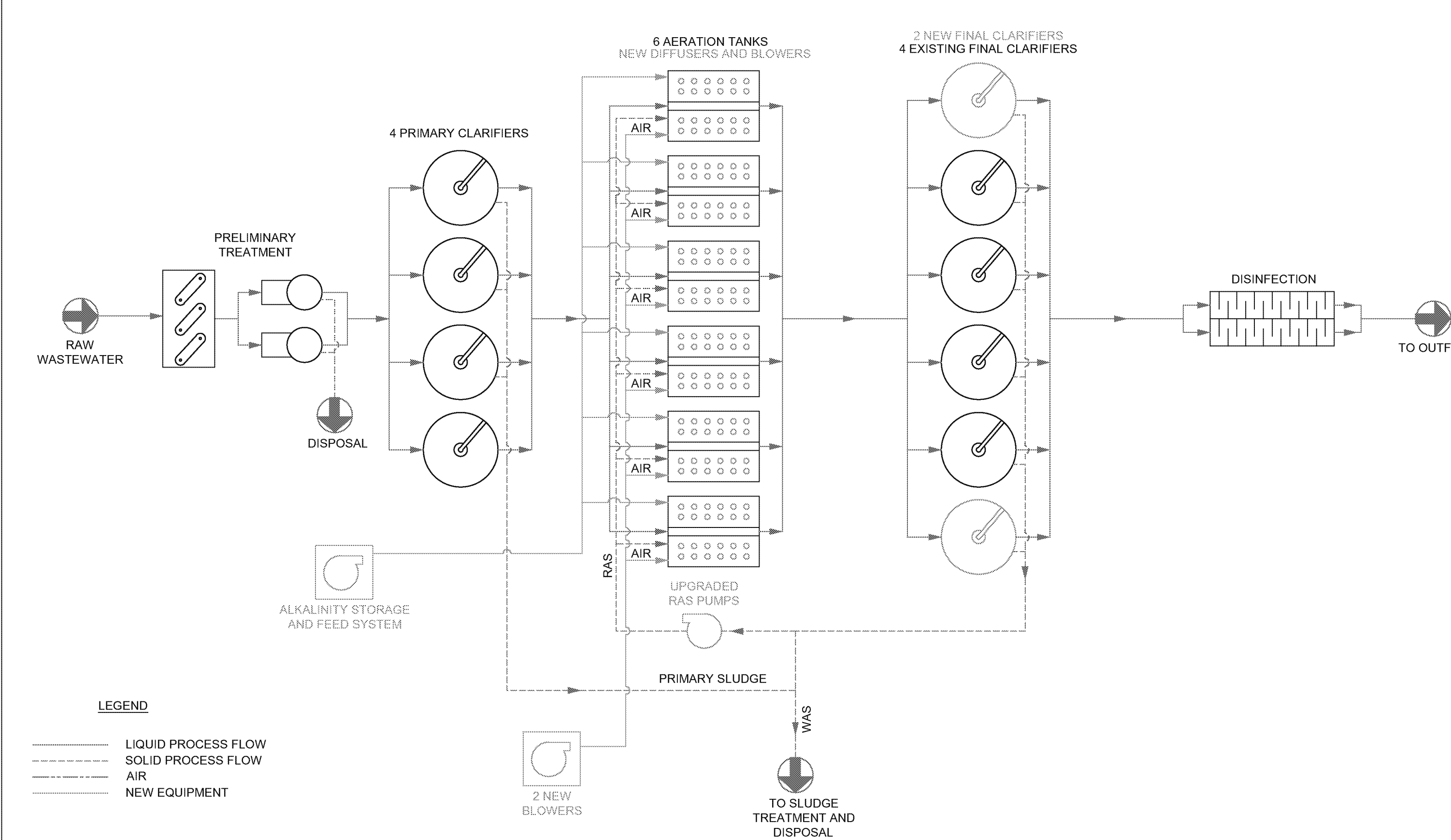


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PROJECT NO.	6736	GENERIC CONVENTIONAL ACTIVATED SLUDGE PLANT EXISTING CONDITIONS	FIGURE 7
DRAWN BY	ELD		
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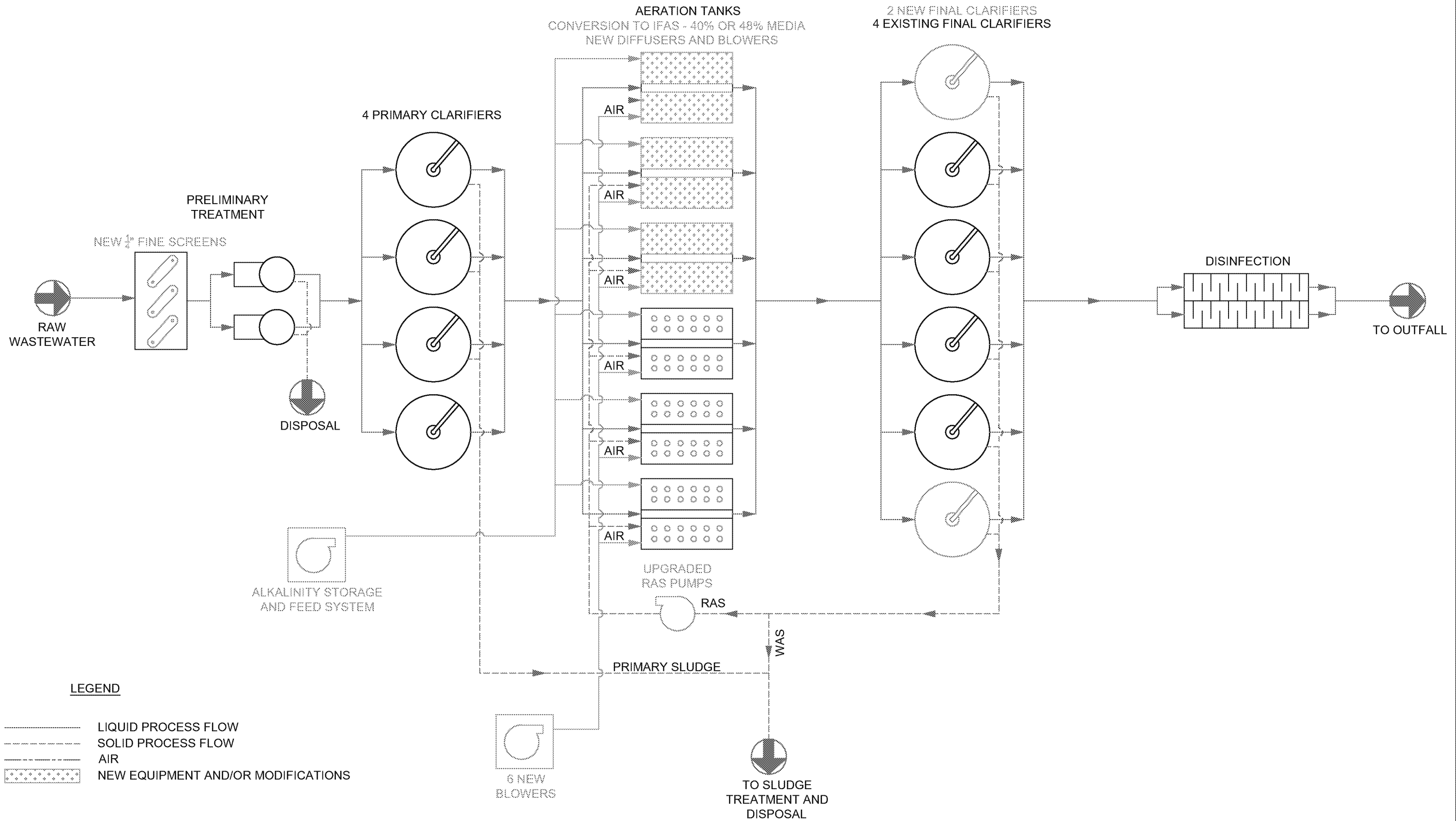
CAD FILE: S:\6736 - DRBC Cost Study\DWG\6736_PFDs.dwg LAYOUT: Conventional NH3 10 PLOTTED: 10/22/2019 5:33 PM BY: erin dovel



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PROJECT NO.	6736	GENERIC CONVENTIONAL ACTIVATED SLUDGE PLANT NH3 - 10 MG/L	FIGURE 8
DRAWN BY	ELD		
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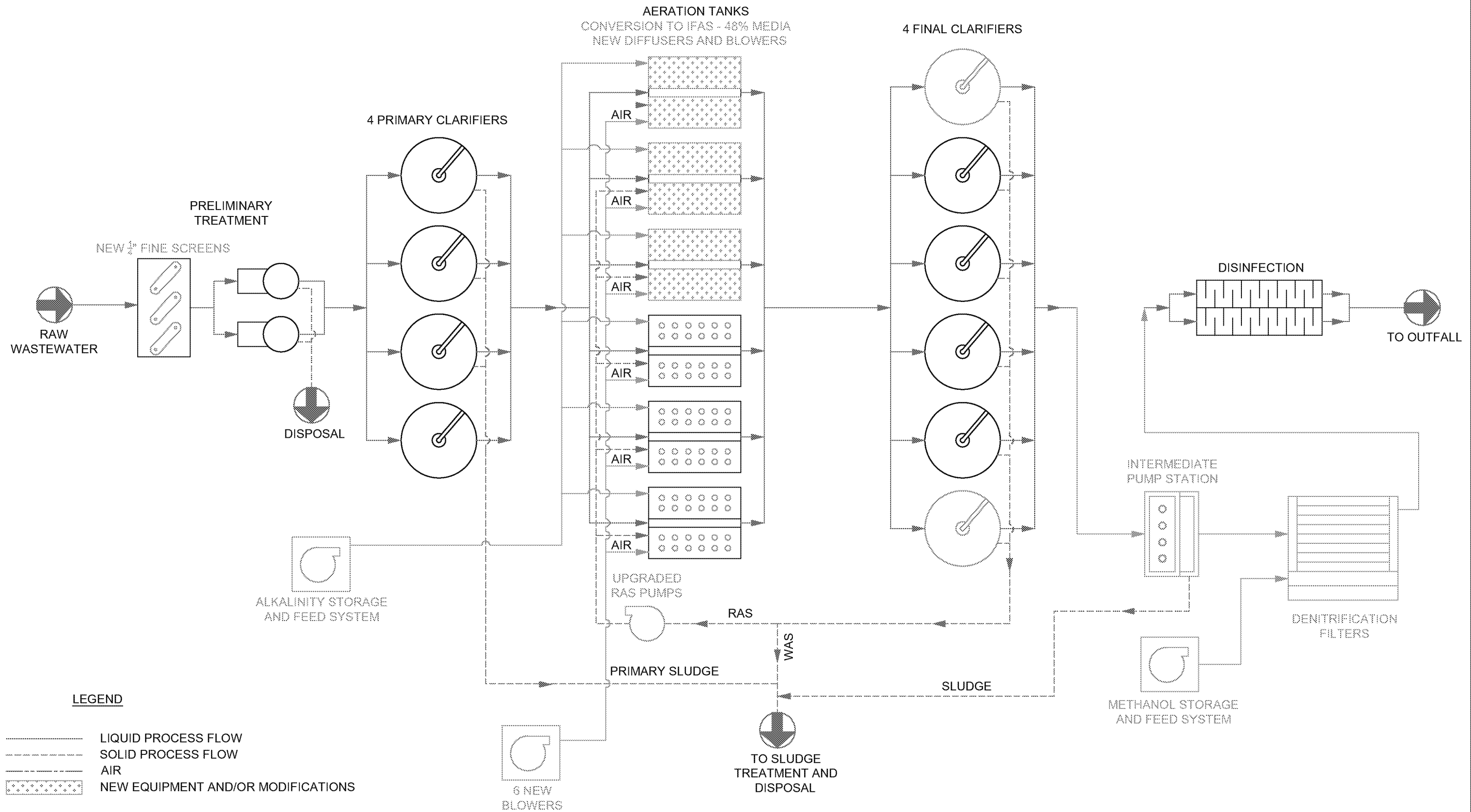
LEGEND

- LIQUID PROCESS FLOW
- SOLID PROCESS FLOW
- AIR
- NEW EQUIPMENT AND/OR MODIFICATIONS

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PROJECT NO.	6736	GENERIC CONVENTIONAL ACTIVATED SLUDGE PLANT NH3 - 5 MG/L OR 1.5 MG/L	FIGURE 9
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PROJECT NO.	6736	GENERIC CONVENTIONAL ACTIVATED SLUDGE PLANT NH3 - 1.5 MG/L AND TN - 4 MG/L	FIGURE 10
DRAWN BY	ELD		
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DATE:	09-10-19		
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